FUTURE DIRECTIONS

OF

ATMOSPHERIC CHEMISTRY RESEARCH

CACGP

Comission on Atmospheric Chemistry and Global Pollution
(CACGP)

of

International Association of Meteorology and Atmospheric Sciences
(IAMAS)

10th CACGP Symposium / 7th IGAC Science Conference

Crete, Greece, September 19-25, 2002

Prepared by CACGP Officers (1998-2002), September 2002.

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PREFACE

Global atmospheric chemistry research evolved in the late 1980's in response to growing international concern about rapid atmospheric composition change on a global scale, raising global environmental issues such as global warming, stratospheric ozone depletion, acid deposition, etc. CACGP realized a need for a comprehensive research program addressing issues related to the changing composition of the global atmosphere, and took a lead in the creation of the International Global Atmospheric Chemistry (IGAC) project in 1988 under the leadership of then President, R. Duce and Secretary, H. Rodhe.

After flourishing ten years of activity, IGAC decided to publish a book on integration and synthesis of the extensive scientific knowledge accumulated during the period, and also started discussions on the second phase of IGAC at the IGAC Science Conference in Bologna, Italy, in September 1999. CACGP realized the need for discussion on new directions of global atmospheric chemistry research in the next decade and organized a session on "Future Needs in Atmospheric Chemistry Research" at the Bologna Meeting. Following this, the IGAC Integration and Synthesis Meeting was held in Aspen, USA in April-May 2000 led by then IGAC Chair, G. Brasseur. CACGP organized a workshop on "Priorities in International Chemistry Research and the Future of IGAC" on this occasion.

Through a series of discussions CACGP recognized that as scientific understanding of the elements of atmospheric chemistry has developed, the linkage between atmospheric composition and other components of the Earth System should be strengthened more explicitly. Ten years ago, the "Earth System" was a rather abstract idea. Now, we are on the threshold of a more quantitative understanding of the role of atmospheric chemistry in Earth System processes and of developing strategies to integrate that knowledge into a predictive capability. It also identified the need to recognize the societal importance of atmospheric chemistry. This booklet entitled "Future Directions of Atmospheric Chemistry Research" is the product of this series of discussions.

We appreciate greatly the helps of all the participants of the above two meetings who made important contribution to the idea appearing in this booklet. We hope it will help young scientists to plan future research activities in atmospheric chemistry either within or outside of IGAC.

For the convenience of readers, a chapter describing CACGP is included in this booklet together with appendices covering organizational framework surrounding CACGP, a brief history of CACGP and the present membership. These materials are largely based on a handout prepared by former CACGP president, H. Rodhe, which was distributed at the previous CACGP meetings. We hope it will help the reader to become more familiar with CACGP.

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President, CACGP

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1. SOCIETAL IMPORTANCE OF ATMOSPHERIC CHEMISTRY

Atmospheric chemistry research offers critical support in maintaining the fundamental necessities for human existence, namely, water supply, food production, human health and ecosystem health. Table 1 lists the main chemical groups in the atmosphere that influence these essential environmental elements. Although climate change does not appear explicitly, it is a major indirect effect of atmospheric chemical composition change and feedbacks upon chemical processes through changes in climate. Atmospheric chemicals are key components of the climate system through the global cycles of carbon, nitrogen, and sulfur and also through the cycles of ozone and aerosols.

Table 1 The key environmental issues of the first decade of the 21st century and associated atmospheric chemical groups that should be the focus of multidisciplinary research involving atmospheric chemistry.

Water Supply	Human Health	Food Production	Ecosystem Health
GHGs	oxidants	oxidants	nutrients
aerosols	aerosols	aerosols	acids
ozone	toxics		oxidants

Water supply which is the most essential to the existence of life on

Earth, is directly affected by the change of hydrological cycles induced by shifts in climate. Climate change is brought about by changes in the warming effect of the increasing concentration of long-lived greenhouse gases (CO_2, CH_4 and N_2O, chlorofluorocarbons) and tropospheric ozone as well as the cooling and warming effects of aerosols. Particular concern should be regional climate change in developing countries where people and food production are most vulnerable to changes in water supply. Regional climate will be especially affected by aerosols and other urban smog constituents which, due to shorter lifetimes in the atmosphere, have much more regional variability than the classical greenhouse gases.

Food production is a major concern for human beings as global population grows rapidly in the 21st century. It is not only dependent on water supply but also on an atmosphere sufficiently devoid of human induced chemical perturbations that plant productivity and the toxic effects of chemicals through the food chain are minimized. Ozone and related pollution are known to inhibit photosynthesis and to damage leaves and needles thereby reducing crop productivity. By reducing sunlight at the ground, aerosols can also reduce photosynthesis.

Human health and productivity is adversely affected by air pollution. This is recognized in regulatory standards in many countries. Reactive gases such as sulfur dioxide, ozone, nitrogen dioxide, carbon monoxide and aerosols directly affect the respiratory system and optimal functioning of the body. Toxic substances, through inhalation and ingestion of food, play a role in reducing optimal human function, productivity and longevity. These include heavy metals (e.g. mercury), persistent organic pollutants (e.g. chlorinated synthetic compounds and by-products such as PCBs, dioxins/furans; herbicide/pesticides) and urban air pollution constituents (e.g. benzo(a)pyrene and nitrogenated polycyclic aromatics in diesel soot). Despite the heightened awareness of air pollution effects in the last half of the 20th century, major pollution problems persist particularly associated with rapidly developing economies and, in all countries, with pollutant constituents that are so difficult to measure (short lived oxidants and hydrocarbon compounds) that regulatory agencies do not have a sufficiently solid information base to set air quality standards. Even though efficient emission control technologies exist for many chemicals, implementation has not kept pace with development or rapid increase in emissions. For instance, nitrogen oxide levels in many places in North America have not decreased despite the reduction of tailpipe emissions achieved by improved combustion gas treatments in automobiles. The growth in numbers of autos offsets the cleaner exhaust. Solutions to the air pollution and human health problem involve matching the appropriate technological to the particular social situations in various regions.

The *health of terrestrial ecosystems* is jeopardized by exposure to elevated levels of pollutant gases such as ozone and deposition of acids and nutrients such as nitrogenous species. As noted above ozone retards photosynthesis and stresses plants. Forest die-back in suburban areas caused by high concentration of photooxidants is well known. As smog in- and downwind of developing regions increases, the combined stress of acidic deposition and direct leaf damage results in forest decline and agricultural damage. There is a large body of evidence that ozone reduces agricultural productivity. In some regions, acidic gases such as sulfur dioxide affect trees and other plants. The effect of acid rain is complex since acidification of soil is the primary cause of the stress rather than the direct toxicity to trees. The adverse effects of acids are not only due to sulfuric acid but also deposition of nutrients such as nitrate and ammonium. These affect the uptake of essential trace elements by roots and hence, ecosystem health. Chemicals in the atmosphere indirectly stress ecosystems through climate change. It is often difficult to unravel the combined effects of the direct pollutant insult to an ecosystem from the indirect stress of changing climate. A good example of this is the maple forest die-back in the northeastern US and eastern Canada which was initially attributed to acid rain but later acknowledged to be also due to anomalous climatic conditions that affected these ecosystems.

2. THE GOALS OF ATMOSPHERIC CHEMISTRY RESEARCH IN THE NEXT DECADE

The ultimate goal of atmospheric chemistry research is to contribute to solving the basic societal issues of water supply, food production and human/ecosystem health. This is done through an enhanced understanding of the fundamental mechanisms that control atmospheric composition and development of improved predictive capabilities. In order to accomplish this target, we propose the advancement of a well-focused scientific research program with strong societal relevance. It is widely acknowledged that a variety of research communities are necessary to understand atmospheric chemical processes and impacts and to implement strategies that resolve problems that arise. These are schematically depicted in Figure 1.

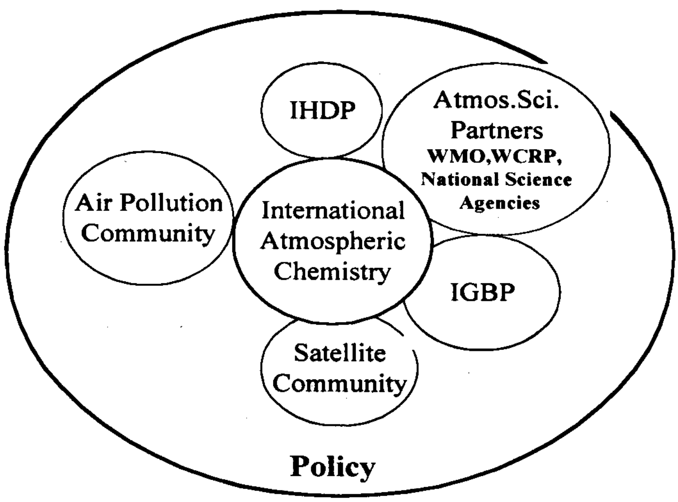


Figure 1 Partners of the international atmospheric chemistry research community in the global effort to manage global environmental change. (IHDP: International Human Dimensions Program, WMO: World Meteorological Organization, WCRP: World Climate Research Program).

International atmospheric chemistry research must in the next decade be more closely connected to regional air pollution and national air chemistry research programs. Furthermore, it needs to develop closer ties with observational and data gathering activities of the World Meterological Organization (WMO). Finally it must begin to contribute to the International Human Dimensions Program (IHDP).

Ten years ago, global tropospheric chemistry was in its infancy. Almost no observations of atmospheric composition on a large scale were available, many chemical transformation mechanisms were unknown and global atmospheric chemistry models were to say the least crude. Last decade has seen a renaissance in global atmospheric chemistry research. We now know something about the global cycles (sources, transformation and sinks) of most important atmospheric species. The application of existing satellite observations to tropospheric chemical characterization has been explored to its fullest and new satellites instruments have recently been or are about to be launched. Multi-platform process studies of atmospheric chemical processes have been conducted on an unprecedented scale. Global chemical transport models that utilize observed winds are better at simulating the distribution of key tropospheric species and are capable of generating future global pollution scenarios. Furthermore, short-lived, radiatively-active substances such as ozone and aerosols have been added as active constituents to the global climate models.

As scientific understanding of the elements of atmospheric chemistry has been developed, the necessity of understanding the linkage between atmospheric composition and other components of the Earth System has been realized more explicitly. Ten years ago, the "Earth System" was a rather abstract idea. Now, we are on the threshold of a more quantitative understanding of the role of atmospheric chemistry in Earth System processes and of developing strategies to integrate that knowledge into a predictive capability.

In the past two years, considerable deliberation by the global community on the future direction of atmospheric research has been fostered by the Commission on Atmospheric Chemistry and Global Pollution (CACGP) and the International Global Atmospheric Chemistry (IGAC). The recommended objectives of global atmospheric research in the next decade are as follows:

1. ***To provide a fundamental understanding of the processes that govern the behavior of chemical compounds in the atmosphere and their impact on climate.***
2. ***To contribute with partners (Fig. 1) to the development of an integrating framework describing the physical, chemical and biological interactions between the different components of the Earth system.***
3. ***To improve our ability to predict atmospheric composition over the coming decade through integrating models, with process studies and comprehensive data sets.***
4. ***To address societal needs through application of atmospheric chemistry research and development of research that integrates human dimensions into Earth System science.***

3. TOWARD THE INTEGRATION

After a decade of interdisciplinary cooperation focused on understanding atmospheric chemistry on a global scale, it is now time to not only maintain the momentum gained from a decade of atmospheric chemistry research but also to begin to integrate atmospheric chemistry into Earth System science while focusing upon environmental aspects of the solutions to socio-economic problems. Integration must take place simultaneously from a variety of perspectives and therefore achieve the comprehensiveness needed for the problem at hand while taking advantage of a research community whose interests, skills and perspectives are equally multi-dimensional.

3.1 Integration of Earth system components

In the next ten years, a focus on the chemical interactions between atmosphere and land as well as the atmosphere and ocean is high priority. Just as global climate models move toward the physical coupling of atmosphere and ocean, atmospheric chemistry must move toward chemically coupling the atmosphere to components of the Earth's surface. This necessity is recognized in a project that has been launched under the International Geosphere/Bioisphere Programme (IGBP). The Surface-Ocean Lower-Atmosphere Study (SOLAS) sponsored by the International Science Commissions (SCORE) and CACGP as well as IGBP is aimed at understanding chemical interactions and feedbacks between these two Earth System components.

Parallel studies to SOLAS that target the chemical interactions of atmosphere and terrestrial ecosystems should be given equally high priority. The Large Scale Biosphere-atmosphere Experiment in Amazonia (LBA) is an outstanding example of an ongoing five-year study that integrates the human dimension with atmospheric chemistry, hydrology, terrestrial ecology for a large terrestrial/freshwater ecosystem that is undergoing massive land surface modification. The Amazon Basin has been recognized as a location of grand ecological and geophysical experiment with deforestation and land-use conversion. Deforestation involves changes of atmosphere-surface exchange of chemicals and has many socio-economic dimensions. The region is studied as one system with human-biosphere-atmosphere-hydrosphere interactions and provides an opportunity to learn about an Earth System regional component in a truly integrated way. This is of particular importance to understanding the coupled change of climate and carbon cycles.

Asia offers another opportunity for an integrated regional. In contrast to the Amazon Basin it is undergoing strong changes in anthropogenic emissions to the atmosphere. The recent INDOEX study and the ongoing ACE-Asia study focused mostly on understanding atmospheric chemistry and climate forcing processes. However, they have laid the groundwork for international cooperation and the contacts necessary to conduct studies of chemical coupling of atmosphere-biosphere and atmosphere-ocean. Such regional studies would have strong links to the SOLAS project mentioned above.

A third integrated regional study that involves interaction between atmosphere and a major land biohme involves the northern boreal forest system of Asia and North America. According to future climate scenarios, this largely natural high latitude ecosystem will be amongst the first to experience climate change. It is also an important reservoir in the global carbon cycle. Furthermore, forest fires in the biohme cause a major seasonal perturbation to tropospheric composition. Increases in temperature have been documented in surface meteorological observations, permafrost borehole temperatures, satellite time series and the seasonal CO_2 cycle. In order to determine if these result from greenhouse warming or natural variability, an integrated approach involving human, biosphere, atmosphere and hydrosphere processes is necessary. Several studies have already laid the groundwork for this type of experiment including the North American Northern Wetlands Study (NOWES), BOREAS and the Mackenzie basin study of GEWEX.

3.2 Integration of knowledge over broad time and space scales

Scales are a very important concept in the study of atmospheric chemistry and environmental science (Fig. 2). Scale links process in space and time. In practical applications of knowledge such as large scale atmospheric chemistry model simulations or determination of chemical sources and sinks atmospheric chemistry processes need to be scaled in space and time. Local, meso-, regional and global scale research is an important component of atmospheric chemistry. Focused continental scale regional studies are of great importance to understand the Earth system in a global perspective since large-scale biomass burning occurs on this scale and the average atmospheric lifetime of aerosols and tropospheric ozone falls in the corresponding time scale. Long-range transport of these species has been studied on this scale since it is the scale of air mass identity. Regional scale studies are connected to global processes by global atmospheric chemistry and climate models. Opportunities for truly integrated studies between atmosphere, hydrosphere, biosphere, and human dimensions can also be developed on a regional scale as mentioned above.

Atmospheric chemistry-climate forcing through aerosols-cloud interaction and its effects on radiation fall into micro to meso-scale spatial scales phenomena. Cloud impacts on atmospheric chemistry and chemical impacts on cloud radiation form an important feedback loop and are of great importance in global change research. Thus, meso-scale research and global scale research are interwoven.

One of the linkages which has not been addressed so far by the international atmospheric chemistry community is that between local, regional and global pollution issues. As mega-cities developed, urban air pollution is becoming mostly a regional atmospheric chemistry issue. The changing scale of urban pollution in the next decade will change the way we address such

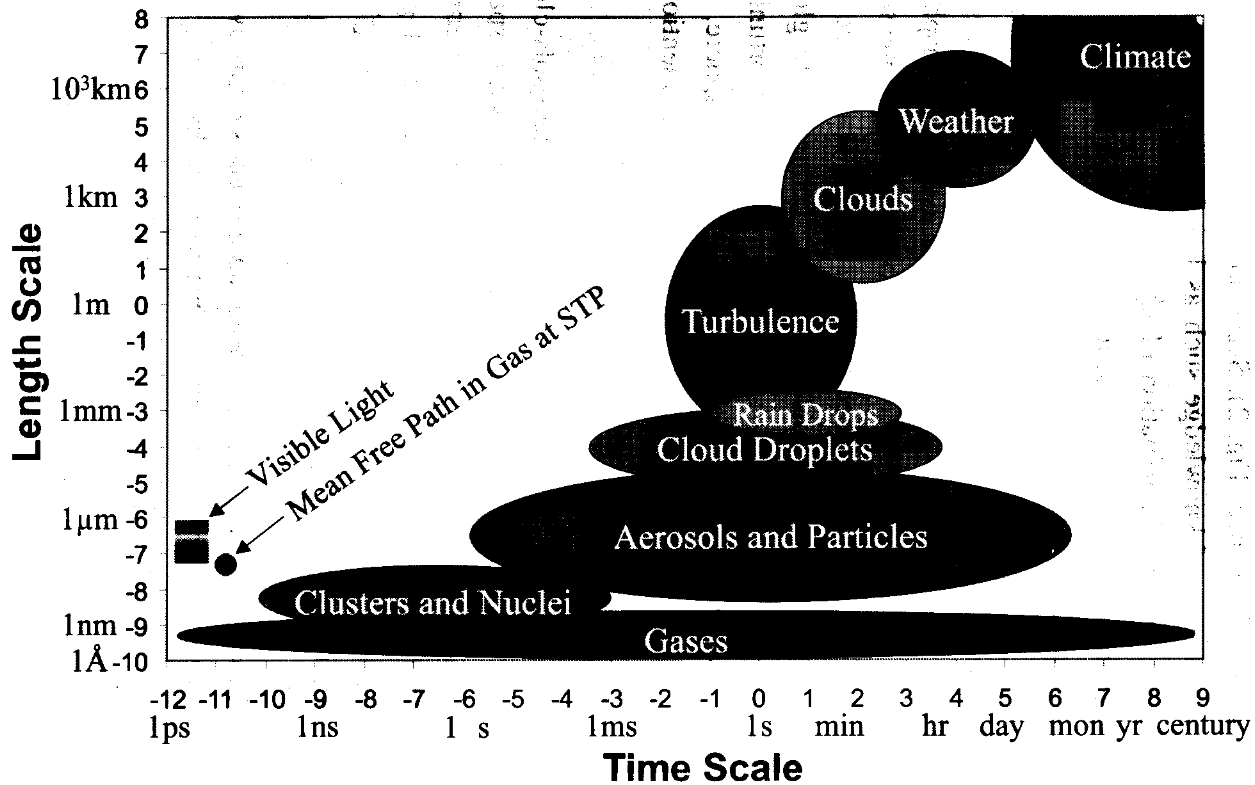


Figure 2 Atmospheric processes, chemicals, weather and climate are linked in space and time (adapted from a personal communication of C. Berkowitz)

problems. Acknowledging urban air pollution as an important driving force of global change through regional air quality change is needed not only for scientific progress but also to achieve optimal use of a finite atmospheric chemistry research resource.

3.3 Integration of science disciplines to solve problems

In order to understand the coupling between the atmospheric composition and other components of the Earth System, much closer linkage of chemistry with physics and biology is necessary. Furthermore, advances in mathematics and computer science must be promptly incorporated into theory and numerical modeling.

More direct coupling between chemistry and physics should be addressed in the study of chemistry-cloud interactions, which is of importance to understand the role of aerosols in radiation budget. Studies on particle scavenging, co-condensation of gases and other water soluble species, chemical impacts on cloud radiation properties, and heterogeneous reactions on cirrus cloud particles, all need more closely coupled knowledge of chemistry and physics. Similarly, the characterization of atmospheric aerosol composition and the heterogeneous chemical processes that control it is a major outstanding research challenge. Collaboration with biological science is also needed to understand the processes controlling the air-sea gas transfer and VOC emission from vegetation.

Integration of science disciplines could best take place through a few focused efforts centered on answering some key fundamental atmospheric chemistry questions such as " what controls OH in the upper troposphere", "what is the chemical mechanism and globally integrated magnitude of ozone destruction in the atmospheric marine boundary layer" and "how is aerosol composition downwind of large source regions affected by chemical transformation".

3.4 Integration of research communities

This type of integration was touched upon above but is worth emphasizing. In order to accomplish the goals of atmospheric chemistry research in the next decade, the atmospheric chemistry community must explore new partnerships and strengthen old ones (see Fig.1). Particular focus should be placed on satellite-based remote sensing of tropospheric chemistry. Although historically, satellite sensors for the observation of atmospheric species were developed for studying stratospheric chemistry, they have proven extremely useful in addressing tropospheric chemistry. Now a whole host of satellite instruments are coming on-line that are specifically designed for tropospheric chemistry studies. Consequently, the role of remote sensing from satellite in atmospheric chemistry research will expand. As satellite sensor systems are made more versatile and global climate models are expanded to the mesopause, the difference between stratospheric and tropospheric chemistry communities is dissolving. In the last decade, IGAC has been focusing on tropospheric chemistry and links with the stratospheric chemistry community have been loose. These links need to be tightened through a focus on the role of troposphere-stratosphere exchange in influencing upper tropospheric and lower stratospheric chemistry or even the merging of stratospheric and tropospheric research institutions.

Another integration is needed between local/regional and global air chemistry researchers and programs. In the past decade, this has occurred in an ad hoc way. Now as urban megacity problems become more prominent, it is important that the global and regional communities are not divided but rather pool resources to scale up the patchwork quilt of local/regional studies to understand the global implications.

The Global Atmospheric Watch (GAW) program of the World Meterological Organization (WMO) coordinates through its meterological service members the only global baseline atmospheric chemistry monitoring network. This network is inadequate in its spatial coverage (e.g. few stations in the tropics and none in the vast boreal region of Russia or Canada) and does not include any routine vertical profiles of atmospheric composition other than ozone. It also runs a series of global data centers in which information from various ground based air chemistry stations are collected. A global atmospheric chemistry research effort needs to integrate not only satellite information but also promote more comprehensive ground based measurements and data gathering programs. Closer cooperation with WMO is in order.

Finally, closer collaboration between major national research programs in the world that are global in scope with the international research effort needs to take place.

4. IMPLEMENTATION OF RESEARCH

The research discussed in the previous section can be implemented through a variety of mechanisms after careful examination of the structure:

a) Integrative regional studies (e.g. LBA, Asia, Boreal)
b) Global model development through intercomparisons involving evaluations with data and close cooperation with the WMO.
c) Promotion of a core set ground level and vertical air chemistry measurements and attendant data analysis centers.
d) Incorporation of satellite researchers and observations into atmospheric chemistry modeling and regional process studies.
e) International specialty workshops
f) Instrument intercomparisons

These will be done through collaboration with other science programs as listed in Table 2.

Table 2 Anticipated research connections between future atmospheric chemistry research and other research programs.

Research Programs	Anticipated Collaboration
SPARC	Close collaboration or even merging research on atmospheric ozone and stratosphere/troposphere exchange
WMO/GCOS/GAW	Global Atmospheric Watch Measurement And Data Analysis Programs Working Group on Numerical Experimentation (WGNE) model intercomparison and evaluation studies
WCRP	Climate modelling Parameterization of cloud- chemical processes
SOLAS	Close collaboration on cycling and exchange of chemicals in the marine boundary layer

IPCC	Emission inventories
IHDP	Explore collaboration
Space Agencies	Atmospheric chemistry processes and use of remotely sensed chemical composition.
National Science Partners	Coordinate to fill gaps not covered by these programs

Commission on Atmospheric Chemistry and Global Pollution (CACGP)

of

International Association of Meteorology and Atmospheric Sciences (IAMAS)

What is CACGP?

The *International Commission on Atmospheric Chemistry and Global Pollution* (CACGP) is one of the commissions in IAMAS *(International Association of Meteorology and Atmospheric Sciences*), which in turn is one of the associations within IUGG *(International Union of Geodesy and Geophysics)* under the non-governmental ICSU *(International Council of Scientific Unions)* family. CACGP is also often referred to as ICACGP within the IAMAS community. IAMAS has several other commissions for example the IOC *(International ozone commission),* and the ICCP *(International Commmission of Cloud and Precipitation),* and inter-commission symposia between ICACGP and those other commissions are usually organized as part of an IAMAS or IUGG Assembly. The organizational framework of international science bodies and programs under ICSU and the governmental UN family that surrounds CACGP is shown in Appendix 1.

What is the activity of CACGP?

The main goals of CACGP are to:

- Promote research on chemistry and composition of the troposphere related to global pollution and climate change;
- Initiate, facilitate and coordinate the research programs in this field which require international cooperation;
- Stimulate discussion and provide publication of the results of such research programs.

The major activity of CACGP has been to organize scientific symposia approximately every four years. The two most recent 8th and 9th symposia were held in Fuji-yoshida, Japan in 1994 and in Seattle, USA in 1998, respectively. The10th symposium is being held in Crete, Greece in 2002.

During the mid 1980's, a growing need was realized for a comprehensive research program addressing issues related to the changing composition of the global atmosphere. Initiatives were taken under the auspices of CACGP, which eventually led to the creation of the International Global Atmospheric Chemistry (IGAC) project in 1988. In 1990 IGAC was accepted as one of the Core Projects of IGBP *(International Geosphere-Biosphere Programme)* under ICSU. After IGAC started to hold its own scientific conferences, CACGP quadrennial symposia have been organized jointly with IGAC science conferences starting with the Fuji-yoshida symposium in 1994.

After ten years of rapid advances in of atmospheric chemistry, the focus of global change research has shifted toward earth system science, concerned with in the close interaction between atmosphere, ocean and land surface (terrestrial ecosystems). Recently, CACGP has endorsed a new scientific project, SOLAS *(Surface Ocean-Lower Atmosphere Study)* together with IGBP and SCORE *(Scientific Committee on Oceanic Research)* under ICSU. IGAC is planing a second phase, IGAC-2. CACGP held a session to discuss "Future Needs in Atmospheric Chemistry Research" at the IGAC Science Conference in Bologna, Italy in 1999. CACGP also organized a workshop on "Priorities in International Atmospheric Chemistry Research and the Future of IGAC" at the IGAC Integration and Synthesis Meeting in Aspen, USA in 2000. The IGAC and SOLAS projects are led by scientific steering committees (SSC) approved jointly by CACGP and IGBP (and SCORE for SOLAS).

In addition to organizing the quadrennial symposia and developing IGAC and other necessary research projects, CACGP sponsors and co-sponsors many symposia in connection with the Assemblies organized by IUGG and IAMAS every two years. The most recent IAMAS Assembly was held in Innsbruck, Austria in July 2001, and the next IUGG Assembly will be held in Sapporo, Japan during June 30-July 11, 2003.

Major points in the history of the commission are summarized in Appendix 2.

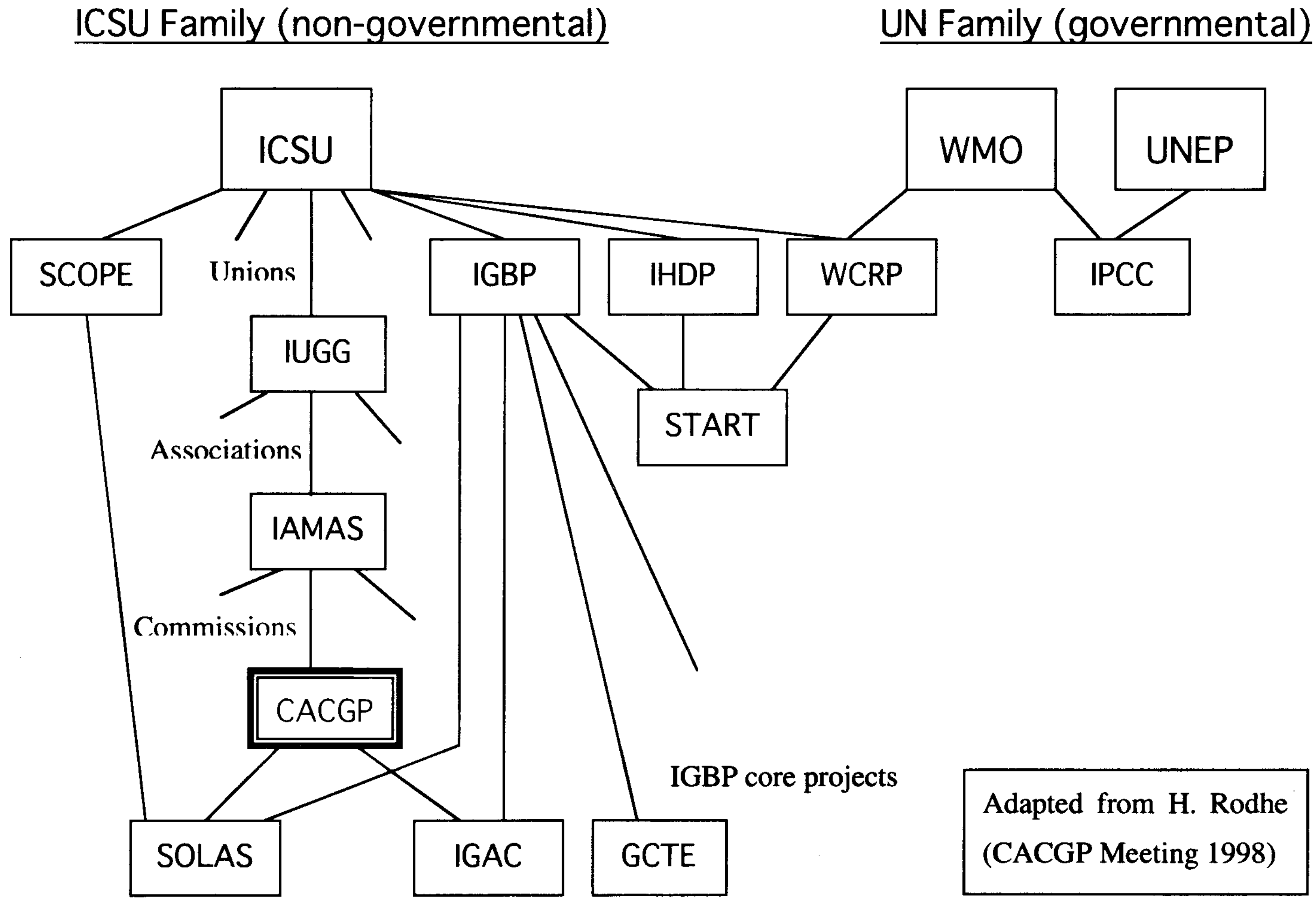
How are CACGP members elected?

Election of officers (president, vice president, and secretary) and members of CACGP takes place at the CACGP closed meeting held on the occasion of the quadrennial CACGP symposium. The term of officers and members ise limited to 8 years in principle so that about a half of the members are due to be replaced at the commission. Nomination of new members is invited from our scientific community as represented by the participants of the CACGP symposium. An open meeting of CACGP is arranged during the symposium and everybody is welcome to attend and nominate new members on this occasion. Nomination by e-mail to one of the officers in advance of the symposium is also accepted.

The present officers and members for 1998-2002 are listed in Appendix 3.

Appendix 1

Organizational Framework Surrounding CACGP



Appendix 2

Brief History of the Commission on Atmospheric Chemistry and Global Pollution (CACGP)

1957	Foundation of the Commission on Atmospheric Chemistry and Radioactivity (CACR)
1957-1963	***President: W. Bleeker, The Netherlands*** ***Secretary: C. E. Junge, FRG***
1960	Symposium on Air Chemistry and Radioactivity at IUGG Assembly in Helsinki, August.
1962	Symposium on Trace Gases and Natural and Artificial Radioactivity in the Atmosphere, Utrecht, The Netherlands, August 8-14. Proceedings published in Journal of Geophysical Research Vol. 68 (1963).
1964-1967	***President: B. Bolin, Sweden*** ***Secretary: E. A. Martell, USA***
1965	Symposium on Atmospheric Chemistry, Circulation and Aerosols, Visby, Sweden, August 18-25. Proceedings published in Tellus, Vol. 18 (1966).
1967-1971	***President: C. E. Junge, FRG*** ***Secretary: E. A. Martell, USA***
1969	Symposium on Atmospheric Trace Constituents and Atmospheric Circulation, Heidelberg, Federal Republic of Germany, September 8-13. Proceedings published in Journal of Geophysical Research, Vol. 75 (1970).
1971	The commission changed its name to Commission on Atmospheric Chemistry and Global Pollution (CACGP).
1971-1975	***President: C. E. Junge, FRG*** ***Secretary: P. Goldsmith, UK***
1973	Symposium on Trace Gases, Mainz, FRG, April 2-6. Proceedings published in Tellus, Vol. 26 (1974).
1974	International Conference on Structure, Composition and General Circulation of the Upper and Lower Atmospheres and Possible

	Anthropogenic Perturbation at IAMAP Assembly, Melbourne, January 1974.
1975-1979	***President: E. A. Martell, USA*** ***Secretary: P. Goldsmith, UK***
1979	Symposium on the Budgets and Cycles of Trace Gases and Aerosols in the Atmosphere, Boulder, USA, August 12-18. Proceedings published in Journal of Geophysical research, Vol. 85 (1980).
1979-1983	***President: P. Goldsmith, UK*** ***Secretary: R. Duce, USA***
1983	Symposium on Tropospheric Chemistry with Emphasis on Sulphur and Nitrogen Cycles and the Chemistry of Clouds and Precipitation, Oxford, UK. August 28 - September 3. Proceedings published in Atmospheric Environment, Vol. 18 (1984).
1983-1990	***President: R. Duce, USA*** ***Secretary H. Rodhe, Sweden***
1985	Atmospheric Carbon Dioxide: Its Sources, Sinks and Global Transport, Kandersteg, Switzerland, September 2-6. Proceedings published in Tellus, Vol. 39B (1987).
1987	Symposium on Global Atmospheric Chemistry, Peterborough, Canada. Proceedings published in Tellus, 40B (1988).
1988	Planning and Formation of the International Global Atmospheric Chemistry Program (IGAC), Dookie, Australia, November 7-11.
1990	IGAC program accepted as a Core Project of IGBP. R. Prinn elected as a Chairman of IGAC SSC.
1990	Symposium on Global Atmospheric Chemistry, Chamrousse, France, September 7-13. Proceedings published in Journal of Atmospheric Chemistry, Vol. 14 (1992).
1990-1994	***President: H. Rodhe, Sweden*** ***Vice President: D. Albritton: USA*** ***Secretary: I. Galbally, Australia***
1993	First IGAC Science Conference, Global Atmospheric–Biospheric

	Chemistry, Eilat, Israel, April 18-22. Proceedings published in Journal of Geophysical Research, Vol. 99 (1994) and in Prinn R.G. (ed.) Global Atmospheric-Biospheric Chemistry, Plenum Press (1994).
1994	Symposium on Global Atmospheric Chemistry, Fuji-yoshida, Japan, September 5-9. Proceedings published in Atmospheric Environment Vol. 30 (1996).
1994-1998	***President: H. Rodhe, Sweden*** ***Vice President: H. Akimoto, Japan*** ***Secretary: L. Barrie, Canada***
1996	G. Brasseur elected as a second Chairman of IGAC SSC.
1998	Symposium on Global Atmospheric Chemistry, Seattle, USA, August 19-25. Proceedings published in Journal of Geophysical Research, Vol. 104 (1999).
1998-2002	***President: H. Akimoto, Japan*** ***Vice President: L. Barrie, Canada*** ***Secretary: P. Artaxo, Brazil***
2000	CACGP Workshop on "Priorities in International Chemistry Research and the Future of IGAC" at the IGAC Integration and Synthesis Meeting, Aspen, USA, April 27-May 2, 2000. Summary report published in a booklet "A Strategic View of Future Research in International Atmospheric Chemistry" (2002).
2001	Surface Ocean – Lower Atmosphere Study (SOLAS) endorsed. P. Liss elected as a Chairman of SOLAS SSC.
2002	Symposium on Atmospheric Chemistry within the Earth System, Greece, September 19-25. Proceedings to be published in International Journal Atmospheric Chemistry and Physics.

(Hajime Akimoto, September 4, 2002.)
(Henning Rodhe, August 7, 1998.)

Members of Comission on Atmospheric Chemistry and Global Pollution (CACGP) 1998- 2002

Officers

Hajime Akimoto (1998)	Japan	President
Leonard A. Barrie (1998)	Switzerland	Vice President
Paulo Artaxo (1998)	Brazil	Secretary

Members

Timothy Bates (1994)	USA
Helene Cachier (1994)	France
Gregory R. Carmichael (1998)	USA
Rosanne Diab (1994)	South Africa
Inez Fung (1994)	USA
John Gras (1998)	Australia
Tim D. Jickells (1998)	United Kingdom
Maria Kanakidou (1998)	Greece
Kimitaka Kawamura (1998)	Japan
Shyam Lal (1990)	India
Katharine S. Law (1998)	United Kingdom
Caroline Leck (1998)	Sweden
Jos Lelieveld (1994)	Germany
Martin Manning (1994)	New Zealand
Joyce Penner (1994)	USA
Patricia Quinn (1998)	USA
Frank Raes (1994)	Itary
Jochen Rudolph (1998)	Canada
Hanwant B. Singh (1998)	USA
Anne Thompson (1994)	USA
Ming-xing Wang (1994)	China

Ex-Officio

Guy Brasseur	Germany	IGAC Chair

Corresponding Members

Peter Warneck	Germany	IUPAC
George Isaac	Canada	ICCP
Roland List	Canada	IAMAS
Robert Hudson	USA	IOC
John M. Miller	Switzerland	WMO
Markku Kulmala	Finland	ICNAA

Honorary Members

Bert Bolin	Sweden
Paul Crutzen	Germany
Robert Duce	USA
Phillip Goldsmith	United Kingdom
Mario J. Molina	USA
Henning Rodhe	Sweden
F. Sherwood Rowland	USA